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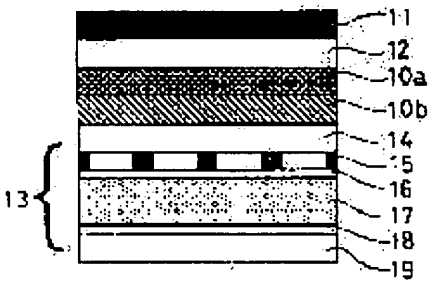
(54) REFLECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To eliminate a picture blur in the normal like direction and to obtain a clear picture by reducing the degree of scattering of the outgoing light beams in the normal line direction of a reflection type liquid crystal display device with respect to other directions.
SOLUTION: The light beams passing through a liquid crystal layer 17 are modulated by applying a voltage to the layer 17 and effective retardation of the layer 17 is reduced with the applied voltage. When the retardation of the layer 17 and a double refraction film 12 become equal, the reflection light beams, which reach a polarizing plate again, become a linearly polarized condition having the same direction of the incident linearly polarized light beams and a bright condition is realized. By electrically controlling the brightness and the darkness in accordance with the RGB of a microcolor filter, a bright color reflection type liquid crystal display element



is obtained. By providing one each of optical scattering layers whose degree of angular dependencies are symmetrical and asymmetrical with respect to the layer normal direction, picture blur is eliminated and the display having a wider visual field angle range is obtained.

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CLAIMS

[Claim(s)]
[Claim 1] The reflected type liquid crystal display element in which it has one polarizing plate, specular reflection board, two or more light-scattering layers, and a liquid crystal layer, and the angular dependence of the light scattering contains [two or more aforementioned light-scattering layers] at least one layer for an unsymmetrical thing and a symmetrical thing respectively about the direction of a layer normal.
[Claim 2] The reflected type liquid crystal display element according to claim 1 which the projection direction to the layer flat surface of the main angle direction of the degree range of diffusion angle makes [in / an unsymmetrical light-scattering layer / in the angular dependence of light scattering] zero azimuth the observation direction of a reflected type liquid crystal display element about the direction of a layer normal, and goes into the range from 90 degrees to 270 degrees counterclockwise.
[Claim 3] The reflected type liquid crystal display element according to claim 1 or 2 whose angular dependence of light scattering is the composition that the symmetrical light-scattering layer made the resin layer distribute a particle about the direction of a layer normal.
[Claim 4] The reflected type liquid crystal display element according to claim 1 or 2 whose angular dependence of light scattering is the light-scattering layer for which a symmetrical light-scattering layer uses the shape of surface toothing about the direction of a layer normal.
[Claim 5] A reflected type liquid crystal display element given in any of the claim 1 characterized by the Hayes value as which a symmetrical thing is defined for the angular dependence of the light scattering by the formula (1) about the direction of a layer normal in a light-scattering layer being 80% or less - a claim 4 they are.
Hayes value =100-(scattered-light permeability)/(all light transmissions) ... (1)
[Claim 6] For at least one layer in an unsymmetrical thing, the Hayes value is a reflected type liquid crystal display element given in any of the claim 1 in which the direction of a layer normal is not included to the degree field of diffusion angle whose angular dependence of the light scattering is 60% or more about the direction of a layer normal in a light-scattering layer - a claim 5 they are.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to a reflected type liquid crystal display.
[0002]
[Description of the Prior Art] In recent years, the application use of a liquid crystal display has accomplished expansion from the calculator to the display of a word processor or a personal computer (PC is called hereafter) by marked improvement in the display performance by progress of liquid crystal display technology. Furthermore, expectation of the commercial-scene expansion as a display of a Personal Digital Assistant (following PDA :P. ersonal Digital Assistant) is growing recently.
[0003] PDA from which a mobile use will be the requisite is said from the character, is asking for the thin and light display of low power, and is a reflected type liquid crystal display (LCD is called hereafter) for which SHIZU which agrees most in it does not need a back light. The great portion of PDA actually produced commercially now has adopted reflected type LCD. It is predicted that PDA builds the huge market of the mini note PC and new mobile PC which serves as the leading role of a multimedia time while uniting and specializing with Network PC further. From now on, reflected type LCD will play the still more important role as the key device.
[0004] Drawing 5 shows the composition of the conventional reflected type LCD, and is the block diagram of a clock besides PDA, a calculator, and reflected type LCD using TN liquid crystal used for general electronic equipment. In drawing 5 , polarizing plates 51a and 51b exist in the opposite superficies of the substrates 53a and 53b which formed the transparent-electrode groups 54a and 54b of the couple which pinches the liquid crystal layer 55, respectively. A reflecting plate 57 is formed in the rear face of polarizing plate 51b through the high refractive-index layer 59. Usually, the high refractive-index layer 59 consists of an acrylic paste, and joins polarizing plate 51b and a reflecting plate 57 as a glue line.
[0005] The liquid crystal layer 55 is passed, it is reflected by the reflecting plate 57, and outgoing radiation of the light which carried out incidence from the polarizing plate 51a side is again carried out to the polarizing plate 51a side. By impressing voltage to the liquid crystal layer 55, the light which passes the liquid crystal layer 55 can be modulated.
[0006] By the way, one of the technical problems of reflected type LCD is "color display." In order to make color display realize, the method which forms the micro light-filter layer of red and blue, and three green colors in a liquid crystal panel inside is usually taken. At penetrated type LCD, reduction of the permeability in a micro light-filter layer is compensated with the back light of high brightness. It is difficult to, use a micro light-filter layer on the other hand, since there is no back light, of course at reflected type LCD, and, now, "a monochrome display" is in use.

[0007] However, the measure for color-display-izing in reflected type LCD is prosperous. Two of methods which the permeability of the method (2) liquid crystal panel using the form birefringence of (1) liquid crystal is raised as the method of the realization, and uses a light-filter layer can be considered.
[0008] (1) changes form birefringence and it makes it realize color display by controlling the voltage impressed to a liquid crystal layer among this. By this method, multiple-color-izing of five or more colors is difficult from restrictions of gradation nature, the controllability of liquid crystal thickness, etc., and it is not suitable for full-scale color display.
[0009] Next, the method of (2) is a method which enabled application of a light filter by using [the place which uses two polarizing plates in the present panel composition] one use or the liquid crystal mode of operation made unnecessary for a polarizing plate, and raising the permeability of a liquid crystal panel. As one of the actual examples, guest host mode is used as a liquid crystal mode of operation, a light-filter layer is formed in a panel inside, and there is the method of impressing the voltage from 2 terminal element to a liquid crystal layer through a reflector, and controlling light modulation (a sharp technical report, No. 56, 27, (1993)). Reflected type LCD in which color display is possible is realized by this method. moreover -- as the method using one polarizing plate -- reflected type STN LCD -- setting -- a liquid crystal layer and optical compensation -- the retardation of a member and a polarizing plate, and optical compensation -- there is an example which makes light modulation of white and black possible by specifying the optical axis of a member (JP,7-84252,A) Color display is theoretically possible if a light-filter layer is combined with this.
[0010] Moreover, although a reflector is used by the above-mentioned method, even if it sees from which angle like "paper", in order to attain the performance of being bright, it is important to give diffuse reflection nature to the inside of panel composition.
[0011] As a conventional example of the reflected type liquid crystal display element using the light-scattering layer, there is a thing using the forward-scattering film indicated by JP,08-201802,A. Drawing 6 shows the liquid crystal panel structure, and, for 60, as for a polarizing plate and 62, a forward-scattering film and 61 are [a birefringence film and 63] the composition that in a transparent substrate and 65 a transparent electrode, 67 liquid crystal layers, and 68 call it a specular reflection board, and a light filter and 66 call [a liquid crystal cell and 64] 69 a bottom substrate.
[0012]
[Problem(s) to be Solved by the Invention] However, in panel composition like the aforementioned conventional example (JP,8-201802,A), if the dispersion performance of a scattering layer is too high in the direction of a normal of the reflected type liquid crystal display element which is an observer's main observation direction when the degree field of diffusion angle of a light-scattering layer is the direction of an omnidirection, light will be scattered about at the time of outgoing radiation, and the technical problem that bleeding of a picture arises occurs.
[0013] Moreover, since light diffuses in the direction of an omnidirection in a scattering layer, the parts of the outgoing radiation light from a liquid crystal display element are scattered about in the direction which an observer does not look at. Since the outgoing radiation light of the part is not used effectively, the reflection factor in the observation direction becomes low, and sufficient luminosity in a white display is not obtained, but the technical problem that the fall of contrast arises occurs.
[0014] On the other hand, if directivity is given in the dispersion direction too much, the ratio of the regular reflection from a reflector will become high, and it will deviate from a property with few viewing-angle dependencies like the paper made into an ideal. In view of the above-mentioned technical problem, it is comparatively easy composition, a white display is bright, a black display is fully dark, high contrast is acquired, and this invention aims at offering the reflected type liquid crystal display element which has a display property without picture dotage.

[0015]
[Means for Solving the Problem] In order to solve the aforementioned technical problem, the reflected type liquid crystal display element of this invention is characterized by the angular dependence of the light scattering making [two or more aforementioned light-scattering layers] an unsymmetrical thing and a symmetrical thing the composition in which at least one layer is included respectively about the direction of a layer normal in the reflected type liquid crystal display element which has one polarizing plate, specular reflection board, two or more light-scattering layers, and a liquid crystal layer.
[0016] Good monochrome display is attained by this, high contrast is acquired, and picture dotage does not arise in the direction of a normal of the reflected type liquid crystal display element which is an observer's main observation direction, but clear image display is obtained.
[0017]
[Embodiments of the Invention] Invention of this invention according to claim 1 One polarizing plate and specular reflection board, Have two or more light-scattering layers and liquid crystal layers, and two or more aforementioned light-scattering layers consider as the reflected type liquid crystal display element characterized by being the composition that the angular dependence of the light scattering contains at least one layer for an unsymmetrical thing and a symmetrical thing respectively about the direction of a layer normal. By weakening the diffusibility of the outgoing radiation light to the direction of a normal of the reflected type liquid crystal display element which is the main observation direction, and scattering the incident light from [other than the main observation direction] an angle in the main observation direction by the light-scattering layer with the unsymmetrical angular dependence of light scattering There is no picture dotage and the white display with a high reflection factor can be obtained. Furthermore, by doubling and using a light-scattering layer with the symmetrical angular dependence of light scattering, mirror reflection light with the directivity from a reflector is eased, and the loose display property of a viewing-angle dependency can be realized.
[0018] The angular dependence of light scattering sets invention of this invention according to claim 2 in the aforementioned unsymmetrical light-scattering layer about the direction of a layer normal. It considers as the reflected type liquid crystal display element to which the projection direction to the layer flat surface of the main angle direction of the degree range of diffusion angle is characterized by going into the range from 90 degrees to 270 degrees counterclockwise by making the observation direction of a reflected type liquid crystal display element into zero azimuth. By making it scattered about to the incident light from angle within the limits of 270 degrees from 90 azimuths which can be made to be able to depend for the dispersion intensity to the incident light to a light-scattering layer on the degree of incident angle, can change, and occupy the great portion of quantity of light which reaches an observer side There is an operation which condenses the reflected light to an observer side and obtains the white display with a high reflection factor. Moreover, since the dispersion nature of the outgoing radiation light from the angle range by the side of the observer of -90 to less than 90 degrees has weak direction of a normal and azimuth of a reflected type liquid crystal display element which are the observation directions main for an observer, there is an operation which picture dotage does not arise but acquires a clear picture.
[0019] As for invention of this invention according to claim 3, the angular dependence of light scattering is related in the direction of a layer normal. the symmetrical aforementioned light-scattering layer By light being scattered about by the interface of a resin layer which considers as the reflected type liquid crystal display element characterized by being the composition of having made the resin layer distributing a particle, and is mutually [a refractive index] different, and a particle The light-scattering layer which has a light-scattering property the angular dependence is symmetrical about the direction of a layer normal is used as a light-scattering layer of a reflected type liquid crystal display element. By taking this composition, a viewing-angle dependency is loose and can attain the

reflective display property near a display like paper.

[0020] As for invention of this invention according to claim 4, the angular dependence of light scattering is related in the direction of a layer normal. the symmetrical aforementioned light-scattering layer By considering as the reflected type liquid crystal display element characterized by being a light-scattering layer using the shape of surface toothing, making the front face into the shape of toothing, changing the transparency direction of light by the place, and scattering light The light-scattering layer which has a symmetrical light-scattering property about the field where the angular dependence includes the direction of a layer normal is used as a light-scattering layer of a reflected type liquid crystal display element. By taking this composition, if it compares with the above-mentioned invention according to claim 3, directivity can realize the bright white display of a certain thing to a viewing-angle dependency.

[0021] In the aforementioned light-scattering layer, about the direction of a layer normal, as for invention of this invention according to claim 5, the angular dependence of the light scattering can realize the loose display of a viewing-angle dependency because a symmetrical thing uses for the Hayes value to be 80% or less as the reflected type liquid crystal display element by which it is characterized, and makes picture dotage mitigate by holding down the Hayes value and you make it scattered about in all the directions.

[0022] In the aforementioned light-scattering layer, as for invention of this invention according to claim 6, the angular dependence of the light scattering is related in the direction of a layer normal. at least one layer in an unsymmetrical thing By considering as the reflected type liquid crystal display element characterized by not including the direction of a layer normal to the degree field of diffusion angle the Hayes value of whose is 60% or more, and making the Hayes value over the incident light from [of a light-scattering layer] a normal less than 60% There is an operation from which the picture dotage by the direction of a normal of the reflected type liquid crystal display element which are the main observation directions is made to mitigate, and a clear picture is acquired for an observer. Moreover, there is an operation which diffuse the incident light in the field, and it is made to condense in the main observation direction, and realizes good monochrome display according to the Hayes value in angle fields other than the above being as high as 60%.

[0023] Hereafter, the gestalt of operation of this invention is explained using drawing 4 from drawing 1 .

(Gestalt 1 of operation) Drawing 1 and drawing 2 show (the gestalt 1 of operation).

[0024] drawing 1 -- setting -- 10a -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- an unsymmetrical light-scattering layer and 10b -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- a symmetrical light-scattering layer and 11 -- a polarizing plate and 12 -- a birefringence film and 13 -- a liquid crystal cell and 14 -- in a transparent electrode and 17, a liquid crystal layer and 18 show a reflector and 19 shows [a bottom transparent substrate and 15 / a light filter and 16] a bottom

[0025] Drawing 2 is a conceptual diagram which defines the angle of the incident light to a light-scattering layer. 20 shows the direction of a normal of a light-scattering layer, and the vertical angle theta from [22] a normal and the azimuth [24] phi on the basis of the direction of an observer. [the direction of an incident light and 22 carried out a light-scattering layer and 21, and] [23]

[0026] The glass substrate was used as the bottom transparent substrate 14 and a bottom substrate 19. The thing of the band-like array of red, green, and blue was formed in the front face of the bottom transparent substrate 14 by photo lithography by the pigment-content powder type as a light filter 15, and the pixel electrode was further formed by the indium, tin, and oxide (ITO) as a transparent electrode 16 on it.

[0027] Moreover, on the bottom substrate 19, aluminum was formed by the spatter and the

predetermined reflector 18 was further formed by photo lithography. This reflector 18 carries out specular reflection of the light.

[0028] On the transparent electrode 16 and the reflector 18, after printing the 5wt% solution of the N-methyl-2-pyrrolidinone of polyimide resin and hardening at 220 degrees C, the orientation film was formed by performing orientation processing by the rubbing method using the rayon cloth so that rubbing may become anti-parallel mutually.

[0029] next, the circumference portion of the display pixel field on the bottom transparent substrate 14 -- glass fiber with a diameter of 5.7 micrometers -- 1.0wt(s)% -- the mixed thermosetting seal resin was screen-stenciled, 150 resin beads /with a diameter of 4.5 micrometers were sprinkled by the density of 2 mm on the bottom substrate 19, and the seal resin of each other was stiffened for the bottom transparent substrate 14 and the bottom substrate 19 at 150 degrees C of lamination

[0030] Then, after anisotropy deltan of a refractive index carried out vacuum pouring of the pneumatic liquid crystal of 0.14, formed the liquid crystal layer 17 and obturated by the ultraviolet-rays hardenability resin, ultraviolet rays were irradiated and were stiffened.

[0031] On the bottom transparent substrate 14 of the liquid crystal cell 13 formed by the method mentioned above, the angular dependence of light scattering stuck the film which consists of acrylic resin which distributed the silica particle as symmetrical light-scattering layer 10b about the direction of a layer normal. That whose Hayes value a vertical angle theta is moreover 60% or more as unsymmetrical light-scattering layer 10a to the incident light 21 of angle within the limits of 10 to 60 degrees about the direction of a layer normal with the forward-scattering film (tradename : Rumi Suu Kyi) by Sumitomo Chemical Co., Ltd. for the angular dependence of light scattering was stuck so that the azimuth phi of the projection direction of the main dispersion direction might become phi= 180 degrees. The polarizing plate (SQ1852AP by Sumitomo Chemical Co., Ltd.) of a neutral gray was stuck as a polarizing plate 11 on it at lamination and the pan so that the absorption shaft might accomplish the direction of rubbing of the bottom transparent substrate 14, and the angle of 45 degrees so that the direction of rubbing of the bottom transparent substrate 14 and the lagging axis might cross at right angles that whose retardation value is 490nm as a birefringence film 12 on the light-scattering layer 10a.

[0032] The light which carried out incidence from the polarizing plate 11 side passes the birefringence film 12 and the liquid crystal layer 17, and reaches a reflector 18. In a reflector, light will be in a circular polarization of light state, and the incidence linearly polarized light will be in the linearly polarized light state of the direction which intersects perpendicularly in the place at which the reflected light arrived again at the polarizing plate 11 hard [slight / which has set the difference of the retardation of the birefringence film 12 and the liquid crystal layer 17 as one fourth of the wavelength of light]. At this time, a dark state is realizable. That is, it is normally black mode.

[0033] Furthermore, the light which passes the liquid crystal layer 17 can be modulated by impressing voltage to the liquid crystal layer 17. The effective retardation of the liquid crystal layer 17 decreases with the voltage to impress. When the retardation of the liquid crystal layer 17 and the birefringence film 12 becomes equal, the reflected light will be in the linearly polarized light state of the same direction as the incidence linearly polarized light in the place which reached the polarizing plate 11 again. At this time, the Ming state is realizable.

[0034] As mentioned above, the reflected type liquid crystal display element of bright color display was obtained by making it correspond to RBG of a micro light filter, and controlling light and darkness electrically. With this liquid crystal display element, when the angular dependence of the light scattering prepared [a light-scattering layer] an unsymmetrical thing and one symmetrical thing at a time respectively about the direction of a layer normal, there is no picture dotage and the angle-of-visibility range was able to realize the latus display.

[0035] In the above-mentioned panel composition, the angular dependence of light scattering is

related in the direction of a layer normal. in addition, as unsymmetrical light-scattering layer 10a With the forward-scattering film (tradename : Rumi Suu Kyi) by Sumitomo Chemical Co., Ltd., although the Hayes value used 60% or more of thing to the incident light 21 of angle within the limits of 10 to 60 degrees, a vertical angle theta If it replaces with this and the degree range of diffusion angle uses the thing of 0 times to 50 degrees, the picture in the direction of a normal of a liquid crystal display element will check the bird clapper indistinctly. In the still more nearly same panel composition, the result that the clearness of the picture of the direction of a panel side normal improves has been obtained, so that the light-scattering layer which kept away 5 times, 10 degrees, 20 degrees, and the degree field of diffusion angle for the start angle of dispersion from the layer normal is used.

[0036] Moreover, although the film with which the angular dependence of light scattering consists of acrylic resin which distributed the silica particle as symmetrical light-scattering layer 10b about the direction of a layer normal was used, the film with which the distributed density of a silica particle is raised and the Hayes value becomes 80% was produced, and the indistinctness of a picture became remarkable, when it stuck on the liquid crystal display element of the example of this invention and having been evaluated.

[0037] (Gestalt 2 of operation) Drawing 3 shows the reflected type liquid crystal display element in (the gestalt 2 of operation). Fundamental composition and the production method are the same as that of it of (the gestalt 1 of operation). A different point is the composition of the light-scattering layer 30.

[0038] drawing 3 -- setting -- 30a and 30b -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- an unsymmetrical light-scattering layer and 30c -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- a symmetrical light-scattering layer and 31 -- a polarizing plate and 32 -- a birefringence film and 33 -- a liquid crystal cell and 34 -- in a transparent electrode and 37, a liquid crystal layer and 38 show a reflector and 37 shows [a bottom transparent substrate and 35 / a light filter and 36

[0039] Drawing 4 (a) shows the field where the degree field of diffusion angle of a light-scattering layer is included, and drawing 4 (b) shows the dispersion property of the incident light within a reflected type liquid crystal display element. In drawing 4 (a), 40 shows the field of 90 degrees from 270 degrees from phi= 90 azimuths, and theta= 5 vertical angles, and 41 shows an observer. In drawing 4 (b), 42 shows the field where in a specular reflection board and 44 forward-scattering light and 46 contain outgoing radiation light, and, as for 47, an incident light and 45 contain [a light-scattering layer and 43] phi= 90 azimuths of a reflected type display device, and 270 degrees.

[0040] With the gestalt of this operation, that by which the angular dependence of light scattering performed embossing for the front face of an acrylic resin film as symmetrical light-scattering layer 30c about the direction of a layer normal, and formed the shape of toothing on the front face on the bottom transparent substrate 34 of a liquid crystal cell 33 was stuck. With the forward-scattering film (tradename : Rumi Suu Kyi) by Sumitomo Chemical Co., Ltd., the vertical angle theta stuck that whose Hayes value the angular dependence of light scattering is moreover 60% or more as unsymmetrical light-scattering layers 30a and 30b to the incident light 21 of angle within the limits of 10 to 60 degrees about the direction of a layer normal so that it might become phi= 135 azimuths of the projection direction of the main dispersion direction, and 225 degrees. The degree field of diffusion angle which shows the property that the Hayes value of the unsymmetrical light-scattering layer of these two sheets is 60% or more is included to a field 40.

[0041] The polarizing plate (SQ1852AP by Sumitomo Chemical Co., Ltd.) of a neutral gray was stuck as a polarizing plate 31 on it at lamination and the pan so that the absorption shaft might accomplish the direction of rubbing of the bottom transparent substrate 34, and the angle of 45 degrees so that the direction of rubbing of the bottom transparent substrate 34 and the lagging axis might cross at right angles that whose retardation value is 490nm as a birefringence film 32 on the light-scattering layer.

[0042] By forming the light-scattering layer 30 which was constituted as mentioned above and in which the degree field of diffusion angle to an incident light is included to a field 40 in the gestalt of this operation The incident lights 44 of the range from 90 degrees and phi= 90 azimuths to [from theta= 5 vertical angles] 270 degrees are scattered about at the time of the incidence to a liquid crystal display element, are diffused in the many directions, exceed the direction of a normal, and azimuth phi=-90 degree, and stop diffusing the outgoing radiation light 46 of less than 90 degrees.
[0043] Thereby, it condenses in the direction of an observer 41, and the light from the circumference can be used effectively. Consequently, 14.5% of reflection factors in Y value conversion of contrast 12 and a white display was not only obtained in the transverse-plane property, but it set broadly, picture dotage was lost and it has realized the very clear picture.
[0044] Moreover, it is checking that the same property is acquired also in that by which the degree range of diffusion angle is included in angle within the limits which fulfills the aforementioned conditions, such as phi= 120 degrees, phi= 240 degrees, phi= 150 degrees, and phi= 210 etc. degrees, in the azimuth of the projection direction of the main dispersion direction of the unsymmetrical light-scattering layers 30a and 30b of two sheets.
[0045] In addition, in this invention (gestalt 2 of operation (the gestalt 1 of operation)), as a liquid crystal cell, it is not limited to this mode of operation, and an active drive can be carried out by other simple matrix drives and TFT, and the same effect can be substantially acquired also in the composition using the reflecting plate of a mirror plane.
[0046] moreover, in this invention (gestalt 2 of operation (the gestalt 1 of operation)), although the metallic-reflection electrode which contains aluminum as a component as a specular reflection board was used, the effect made into the aim of invention is not acquired by it in limitation, and even if it uses the metallic-reflection electrode which contains silver as a component, it acquires the same effect -- things are made
[0047] moreover, in this invention (gestalt 2 of operation (the gestalt 1 of operation)), although the position in the reflected type liquid crystal display element of a light-scattering layer was made into the position shown in drawing 1 or drawing 3 , wherever the effect made into the aim of this invention may not necessarily be acquired only within this position and may be in [between a reflecting plate and an observer], the same effect is acquired -- there is no change in things
[0048] In addition, although the example which used the electric-field control birefringence effect as a liquid crystal mode of operation explained in explanation with the gestalt of the above operation, it can carry out similarly using a reflector which was mentioned above about the mode of operation which the use number of sheets of a polarizing plate can display by one or less sheet.
[0049] Furthermore, the content of this invention applicable also to any of the drive by switching elements, such as a simple matrix drive and TFT, is clear.
[0050]
[Effect of the Invention] As mentioned above, according to this invention, dispersion nature of the outgoing radiation light to the direction of a normal of a reflected type liquid crystal display element can be weakened compared with the other directions, in the direction of a normal of the reflected type display device which is an observer's main observation direction, picture dotage does not arise but a clear picture can be acquired. Viewing-angle change of a display property can be made loose by using the light-scattering layer which has isotropic dispersion nature simultaneously with it.

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TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to a reflected type liquid crystal display.

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PRIOR ART

[Description of the Prior Art] In recent years, the application use of a liquid crystal display has accomplished expansion from the calculator to the display of a word processor or a personal computer (PC is called hereafter) by marked improvement in the display performance by progress of liquid crystal display technology. Furthermore, expectation of the commercial-scene expansion as a display of a Personal Digital Assistant (following PDA :P. ersonal Digital Assistant) is growing recently.
[0003] PDA from which a mobile use will be the requisite is said from the character, is asking for the thin and light display of low power, and is a reflected type liquid crystal display (LCD is called hereafter) for which SHIZU which agrees most in it does not need a back light. The great portion of PDA actually produced commercially now has adopted reflected type LCD. It is predicted that PDA builds the huge market of the mini note PC and new mobile PC which serves as the leading role of a multimedia time while uniting and specializing with Network PC further. From now on, reflected type LCD will play the still more important role as the key device.
[0004] Drawing 5 shows the composition of the conventional reflected type LCD, and is the block diagram of a clock besides PDA, a calculator, and reflected type LCD using TN liquid crystal used for general electronic equipment. In drawing 5 , polarizing plates 51a and 51b exist in the opposite superficies of the substrates 53a and 53b which formed the transparent-electrode groups 54a and 54b of the couple which pinches the liquid crystal layer 55, respectively. A reflecting plate 57 is formed in the rear face of polarizing plate 51b through the high refractive-index layer 59. Usually, the high refractive-index layer 59 consists of an acrylic paste, and joins polarizing plate 51b and a reflecting plate 57 as a glue line.
[0005] The liquid crystal layer 55 is passed, it is reflected by the reflecting plate 57, and outgoing radiation of the light which carried out incidence from the polarizing plate 51a side is again carried out to the polarizing plate 51a side. By impressing voltage to the liquid crystal layer 55, the light which passes the liquid crystal layer 55 can be modulated.
[0006] By the way, one of the technical problems of reflected type LCD is "color display." In order to make color display realize, the method which forms the micro light-filter layer of red and blue, and three green colors in a liquid crystal panel inside is usually taken. At penetrated type LCD, reduction of the permeability in a micro light-filter layer is compensated with the back light of high brightness. It is difficult to, use a micro light-filter layer on the other hand, since there is no back light, of course at reflected type LCD, and, now, "a monochrome display" is in use.
[0007] However, the measure for color-display-izing in reflected type LCD is prosperous. Two of methods which the permeability of the method (2) liquid crystal panel using the form birefringence of (1) liquid crystal is raised as the method of the realization, and uses a light-filter layer can be considered.
[0008] (1) changes form birefringence and it makes it realize color display by controlling the voltage

impressed to a liquid crystal layer among this. By this method, multiple-color-izing of five or more colors is difficult from restrictions of gradation nature, the controllability of liquid crystal thickness, etc., and it is not suitable for full-scale color display.

[0009] Next, the method of (2) is a method which enabled application of a light filter by using [the place which uses two polarizing plates in the present panel composition] one use or the liquid crystal mode of operation made unnecessary for a polarizing plate, and raising the permeability of a liquid crystal panel. As one of the actual examples, guest host mode is used as a liquid crystal mode of operation, a light-filter layer is formed in a panel inside, and there is the method of impressing the voltage from 2 terminal element to a liquid crystal layer through a reflector, and controlling light modulation (a sharp technical report, No. 56, 27, (1993)). Reflected type LCD in which color display is possible is realized by this method. moreover -- as the method using one polarizing plate -- reflected type STN LCD -- setting -- a liquid crystal layer and optical compensation -- the retardation of a member and a polarizing plate, and optical compensation -- there is an example which makes light modulation of white and black possible by specifying the optical axis of a member (JP,7-84252,A) Color display is theoretically possible if a light-filter layer is combined with this.

[0010] Moreover, although a reflector is used by the above-mentioned method, even if it sees from which angle like "paper", in order to attain the performance of being bright, it is important to give diffuse reflection nature to the inside of panel composition.

[0011] As a conventional example of the reflected type liquid crystal display element using the light-scattering layer, there is a thing using the forward-scattering film indicated by JP,08-201802,A. Drawing 6 shows the liquid crystal panel structure, and, for 60, as for a polarizing plate and 62, a forward-scattering film and 61 are [a birefringence film and 63] the composition that in a transparent substrate and 65 a transparent electrode, 67 liquid crystal layers, and 68 call it a specular reflection board, and a light filter and 66 call [a liquid crystal cell and 64] 69 a bottom substrate.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, according to this invention, dispersion nature of the outgoing radiation light to the direction of a normal of a reflected type liquid crystal display element can be weakened compared with the other directions, in the direction of a normal of the reflected type display device which is an observer's main observation direction, picture dotage does not arise but a clear picture can be acquired. Viewing-angle change of a display property can be made loose by using the light-scattering layer which has isotropic dispersion nature simultaneously with it.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in panel composition like the aforementioned conventional example (JP,8-201802,A), if the dispersion performance of a scattering layer is too high in the direction of a normal of the reflected type liquid crystal display element which is an observer's main observation direction when the degree field of diffusion angle of a light-scattering layer is the direction of an omnidirection, light will be scattered about at the time of outgoing radiation, and the technical problem that bleeding of a picture arises occurs.
[0013] Moreover, since light diffuses in the direction of an omnidirection in a scattering layer, the parts of the outgoing radiation light from a liquid crystal display element are scattered about in the direction which an observer does not look at. Since the outgoing radiation light of the part is not used effectively, the reflection factor in the observation direction becomes low, and sufficient luminosity in a white display is not obtained, but the technical problem that the fall of contrast arises occurs.
[0014] On the other hand, if directivity is given in the dispersion direction too much, the ratio of the regular reflection from a reflector will become high, and it will deviate from a property with few viewing-angle dependencies like the paper made into an ideal. In view of the above-mentioned technical problem, it is comparatively easy composition, a white display is bright, a black display is fully dark, high contrast is acquired, and this invention aims at offering the reflected type liquid crystal display element which has a display property without picture dotage.

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* NOTICES *

MEANS

[Means for Solving the Problem] In order to solve the aforementioned technical problem, the reflected type liquid crystal display element of this invention is characterized by the angular dependence of the light scattering making [two or more aforementioned light-scattering layers] an unsymmetrical thing and a symmetrical thing the composition in which at least one layer is included respectively about the direction of a layer normal in the reflected type liquid crystal display element which has one polarizing plate, specular reflection board, two or more light-scattering layers, and a liquid crystal layer.

[0016] Good monochrome display is attained by this, high contrast is acquired, and picture dotage does not arise in the direction of a normal of the reflected type liquid crystal display element which is an observer's main observation direction, but clear image display is obtained.

[0017]

[Embodiments of the Invention] Invention of this invention according to claim 1 One polarizing plate and specular reflection board, Have two or more light-scattering layers and liquid crystal layers, and two or more aforementioned light-scattering layers consider as the reflected type liquid crystal display element characterized by being the composition that the angular dependence of the light scattering contains at least one layer for an unsymmetrical thing and a symmetrical thing respectively about the direction of a layer normal. By weakening the diffusibility of the outgoing radiation light to the direction of a normal of the reflected type liquid crystal display element which is the main observation direction, and scattering the incident light from [other than the main observation direction] an angle in the main observation direction by the light-scattering layer with the unsymmetrical angular dependence of light scattering There is no picture dotage and the white display with a high reflection factor can be obtained. Furthermore, by doubling and using a light-scattering layer with the symmetrical angular dependence of light scattering, mirror reflection light with the directivity from a reflector is eased, and the loose display property of a viewing-angle dependency can be realized.

[0018] The angular dependence of light scattering sets invention of this invention according to claim 2 in the aforementioned unsymmetrical light-scattering layer about the direction of a layer normal. It considers as the reflected type liquid crystal display element to which the projection direction to the layer flat surface of the main angle direction of the degree range of diffusion angle is characterized by going into the range from 90 degrees to 270 degrees counterclockwise by making the observation direction of a reflected type liquid crystal display element into zero azimuth. By making it scattered about to the incident light from angle within the limits of 270 degrees from 90 azimuths which can be made to be able to depend for the dispersion intensity to the incident light to a light-scattering layer on the degree of incident angle, can change, and occupy the great portion of quantity of light which reaches an observer side There is an operation which condenses the reflected light to an observer side and obtains the white display with a high reflection factor. Moreover, since the dispersion nature of the outgoing radiation light from the angle range by the side of the observer of -90 to less than 90

degrees has weak direction of a normal and azimuth of a reflected type liquid crystal display element which are the observation directions main for an observer, there is an operation which picture dotage does not arise but acquires a clear picture.

[0019] As for invention of this invention according to claim 3, the angular dependence of light scattering is related in the direction of a layer normal. the symmetrical aforementioned light-scattering layer By light being scattered about by the interface of a resin layer which considers as the reflected type liquid crystal display element characterized by being the composition of having made the resin layer distributing a particle, and is mutually [a refractive index] different, and a particle The light-scattering layer which has a light-scattering property the angular dependence is symmetrical about the direction of a layer normal is used as a light-scattering layer of a reflected type liquid crystal display element. By taking this composition, a viewing-angle dependency is loose and can attain the reflective display property near a display like paper.

[0020] As for invention of this invention according to claim 4, the angular dependence of light scattering is related in the direction of a layer normal. the symmetrical aforementioned light-scattering layer By considering as the reflected type liquid crystal display element characterized by being a light-scattering layer using the shape of surface toothing, making the front face into the shape of toothing, changing the transparency direction of light by the place, and scattering light The light-scattering layer which has a symmetrical light-scattering property about the field where the angular dependence includes the direction of a layer normal is used as a light-scattering layer of a reflected type liquid crystal display element. By taking this composition, if it compares with the above-mentioned invention according to claim 3, directivity can realize the bright white display of a certain thing to a viewing-angle dependency.

[0021] In the aforementioned light-scattering layer, about the direction of a layer normal, as for invention of this invention according to claim 5, the angular dependence of the light scattering can realize the loose display of a viewing-angle dependency because a symmetrical thing uses for the Hayes value to be 80% or less as the reflected type liquid crystal display element by which it is characterized, and makes picture dotage mitigate by holding down the Hayes value and you make it scattered about in all the directions.

[0022] In the aforementioned light-scattering layer, as for invention of this invention according to claim 6, the angular dependence of the light scattering is related in the direction of a layer normal. at least one layer in an unsymmetrical thing By considering as the reflected type liquid crystal display element characterized by not including the direction of a layer normal to the degree field of diffusion angle the Hayes value of whose is 60% or more, and making the Hayes value over the incident light from [of a light-scattering layer] a normal less than 60% There is an operation from which the picture dotage by the direction of a normal of the reflected type liquid crystal display element which are the main observation directions is made to mitigate, and a clear picture is acquired for an observer. Moreover, there is an operation which diffuse the incident light in the field, and it is made to condense in the main observation direction, and realizes good monochrome display according to the Hayes value in angle fields other than the above being as high as 60%.

[0023] Hereafter, the gestalt of operation of this invention is explained using drawing 4 from drawing 1 .

(Gestalt 1 of operation) Drawing 1 and drawing 2 show (the gestalt 1 of operation).

[0024] drawing 1 -- setting -- 10a -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- an unsymmetrical light-scattering layer and 10b -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- a symmetrical light-scattering layer and 11 -- a polarizing plate and 12 -- a birefringence film and 13 -- a liquid crystal cell and 14 -- in a transparent electrode and 17, a liquid crystal layer and 18 show a reflector

and 19 shows [a bottom transparent substrate and 15 / a light filter and 16] a bottom
[0025] Drawing 2 is a conceptual diagram which defines the angle of the incident light to a light-scattering layer. 20 shows the direction of a normal of a light-scattering layer, and the vertical angle theta from [22] a normal and the azimuth [24] phi on the basis of the direction of an observer. [the direction of an incident light and 22 carried out a light-scattering layer and 21, and] [23]
[0026] The glass substrate was used as the bottom transparent substrate 14 and a bottom substrate 19. The thing of the band-like array of red, green, and blue was formed in the front face of the bottom transparent substrate 14 by photo lithography by the pigment-content powder type as a light filter 15, and the pixel electrode was further formed by the indium, tin, and oxide (ITO) as a transparent electrode 16 on it.
[0027] Moreover, on the bottom substrate 19, aluminum was formed by the spatter and the predetermined reflector 18 was further formed by photo lithography. This reflector 18 carries out specular reflection of the light.
[0028] On the transparent electrode 16 and the reflector 18, after printing the 5wt% solution of the N-methyl-2-pyrrolidinone of polyimide resin and hardening at 220 degrees C, the orientation film was formed by performing orientation processing by the rubbing method using the rayon cloth so that rubbing may become anti-parallel mutually.
[0029] next, the circumference portion of the display pixel field on the bottom transparent substrate 14 -- glass fiber with a diameter of 5.7 micrometers -- 1.0wt(s)% -- the mixed thermosetting seal resin was screen-stenciled, 150 resin beads /with a diameter of 4.5 micrometers were sprinkled by the density of 2 mm on the bottom substrate 19, and the seal resin of each other was stiffened for the bottom transparent substrate 14 and the bottom substrate 19 at 150 degrees C of lamination
[0030] Then, after anisotropy deltan of a refractive index carried out vacuum pouring of the pneumatic liquid crystal of 0.14, formed the liquid crystal layer 17 and obturated by the ultraviolet-rays hardenability resin, ultraviolet rays were irradiated and were stiffened.
[0031] On the bottom transparent substrate 14 of the liquid crystal cell 13 formed by the method mentioned above, the angular dependence of light scattering stuck the film which consists of acrylic resin which distributed the silica particle as symmetrical light-scattering layer 10b about the direction of a layer normal. That whose Hayes value a vertical angle theta is moreover 60% or more as unsymmetrical light-scattering layer 10a to the incident light 21 of angle within the limits of 10 to 60 degrees about the direction of a layer normal with the forward-scattering film (tradename : Rumi Suu Kyi) by Sumitomo Chemical Co., Ltd. for the angular dependence of light scattering was stuck so that the azimuth phi of the projection direction of the main dispersion direction might become phi= 180 degrees. The polarizing plate (SQ1852AP by Sumitomo Chemical Co., Ltd.) of a neutral gray was stuck as a polarizing plate 11 on it at lamination and the pan so that the absorption shaft might accomplish the direction of rubbing of the bottom transparent substrate 14, and the angle of 45 degrees so that the direction of rubbing of the bottom transparent substrate 14 and the lagging axis might cross at right angles that whose retardation value is 490nm as a birefringence film 12 on the light-scattering layer 10a.
[0032] The light which carried out incidence from the polarizing plate 11 side passes the birefringence film 12 and the liquid crystal layer 17, and reaches a reflector 18. In a reflector, light will be in a circular polarization of light state, and the incidence linearly polarized light will be in the linearly polarized light state of the direction which intersects perpendicularly in the place at which the reflected light arrived again at the polarizing plate 11 hard [slight / which has set the difference of the retardation of the birefringence film 12 and the liquid crystal layer 17 as one fourth of the wavelength of light]. At this time, a dark state is realizable. That is, it is normally black mode.
[0033] Furthermore, the light which passes the liquid crystal layer 17 can be modulated by impressing

voltage to the liquid crystal layer 17. The effective retardation of the liquid crystal layer 17 decreases with the voltage to impress. When the retardation of the liquid crystal layer 17 and the birefringence film 12 becomes equal, the reflected light will be in the linearly polarized light state of the same direction as the incidence linearly polarized light in the place which reached the polarizing plate 11 again. At this time, the Ming state is realizable.

[0034] As mentioned above, the reflected type liquid crystal display element of bright color display was obtained by making it correspond to RBG of a micro light filter, and controlling light and darkness electrically. With this liquid crystal display element, when the angular dependence of the light scattering prepared [a light-scattering layer] an unsymmetrical thing and one symmetrical thing at a time respectively about the direction of a layer normal, there is no picture dotage and the angle-of-visibility range was able to realize the latus display.

[0035] In the above-mentioned panel composition, the angular dependence of light scattering is related in the direction of a layer normal. in addition, as unsymmetrical light-scattering layer 10a With the forward-scattering film (tradename : Rumi Suu Kyi) by Sumitomo Chemical Co., Ltd., although the Hayes value used 60% or more of thing to the incident light 21 of angle within the limits of 10 to 60 degrees, a vertical angle theta If it replaces with this and the degree range of diffusion angle uses the thing of 0 times to 50 degrees, the picture in the direction of a normal of a liquid crystal display element will check the bird clapper indistinctly. In the still more nearly same panel composition, the result that the clearness of the picture of the direction of a panel side normal improves has been obtained, so that the light-scattering layer which kept away 5 times, 10 degrees, 20 degrees, and the degree field of diffusion angle for the start angle of dispersion from the layer normal is used.

[0036] Moreover, although the film with which the angular dependence of light scattering consists of acrylic resin which distributed the silica particle as symmetrical light-scattering layer 10b about the direction of a layer normal was used, the film with which the distributed density of a silica particle is raised and the Hayes value becomes 80% was produced, and the indistinctness of a picture became remarkable, when it stuck on the liquid crystal display element of the example of this invention and having been evaluated.

[0037] (Gestalt 2 of operation) Drawing 3 shows the reflected type liquid crystal display element in (the gestalt 2 of operation). Fundamental composition and the production method are the same as that of it of (the gestalt 1 of operation). A different point is the composition of the light-scattering layer 30.

[0038] drawing 3 -- setting -- 30a and 30b -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- an unsymmetrical light-scattering layer and 30c -- the angular dependence of light scattering -- the direction of a layer normal -- being related -- a symmetrical light-scattering layer and 31 -- a polarizing plate and 32 -- a birefringence film and 33 -- a liquid crystal cell and 34 -- in a transparent electrode and 37, a liquid crystal layer and 38 show a reflector and 37 shows [a bottom transparent substrate and 35 / a light filter and 36

[0039] Drawing 4 (a) shows the field where the degree field of diffusion angle of a light-scattering layer is included, and drawing 4 (b) shows the dispersion property of the incident light within a reflected type liquid crystal display element. In drawing 4 (a), 40 shows the field of 90 degrees from 270 degrees from phi= 90 azimuths, and theta= 5 vertical angles, and 41 shows an observer. In drawing 4 (b), 42 shows the field where in a specular reflection board and 44 forward-scattering light and 46 contain outgoing radiation light, and, as for 47, an incident light and 45 contain [a light-scattering layer and 43] phi= 90 azimuths of a reflected type display device, and 270 degrees.

[0040] With the gestalt of this operation, that by which the angular dependence of light scattering performed embossing for the front face of an acrylic resin film as symmetrical light-scattering layer 30c about the direction of a layer normal, and formed the shape of toothing on the front face on the bottom transparent substrate 34 of a liquid crystal cell 33 was stuck. With the forward-scattering film

(tradename : Rumi Suu Kyi) by Sumitomo Chemical Co., Ltd., the vertical angle theta stuck that whose Hayes value the angular dependence of light scattering is moreover 60% or more as unsymmetrical light-scattering layers 30a and 30b to the incident light 21 of angle within the limits of 10 to 60 degrees about the direction of a layer normal so that it might become phi= 135 azimuths of the projection direction of the main dispersion direction, and 225 degrees. The degree field of diffusion angle which shows the property that the Hayes value of the unsymmetrical light-scattering layer of these two sheets is 60% or more is included to a field 40.

[0041] The polarizing plate (SQ1852AP by Sumitomo Chemical Co., Ltd.) of a neutral gray was stuck as a polarizing plate 31 on it at lamination and the pan so that the absorption shaft might accomplish the direction of rubbing of the bottom transparent substrate 34, and the angle of 45 degrees so that the direction of rubbing of the bottom transparent substrate 34 and the lagging axis might cross at right angles that whose retardation value is 490nm as a birefringence film 32 on the light-scattering layer.

[0042] By forming the light-scattering layer 30 which was constituted as mentioned above and in which the degree field of diffusion angle to an incident light is included to a field 40 in the gestalt of this operation The incident lights 44 of the range from 90 degrees and phi= 90 azimuths to [from theta= 5 vertical angles] 270 degrees are scattered about at the time of the incidence to a liquid crystal display element, are diffused in the many directions, exceed the direction of a normal, and azimuth phi=-90 degree, and stop diffusing the outgoing radiation light 46 of less than 90 degrees.

[0043] Thereby, it condenses in the direction of an observer 41, and the light from the circumference can be used effectively. Consequently, 14.5% of reflection factors in Y value conversion of contrast 12 and a white display was not only obtained in the transverse-plane property, but it set broadly, picture dotage was lost and it has realized the very clear picture.

[0044] Moreover, it is checking that the same property is acquired also in that by which the degree range of diffusion angle is included in angle within the limits which fulfills the aforementioned conditions, such as phi= 120 degrees, phi= 240 degrees, phi= 150 degrees, and phi= 210 etc. degrees, in the azimuth of the projection direction of the main dispersion direction of the unsymmetrical light-scattering layers 30a and 30b of two sheets.

[0045] In addition, in this invention (gestalt 2 of operation (the gestalt 1 of operation)), as a liquid crystal cell, it is not limited to this mode of operation, and an active drive can be carried out by other simple matrix drives and TFT, and the same effect can be substantially acquired also in the composition using the reflecting plate of a mirror plane.

[0046] moreover, in this invention (gestalt 2 of operation (the gestalt 1 of operation)), although the metallic-reflection electrode which contains aluminum as a component as a specular reflection board was used, the effect made into the aim of invention is not acquired by it in limitation, and even if it uses the metallic-reflection electrode which contains silver as a component, it acquires the same effect -- things are made

[0047] moreover, in this invention (gestalt 2 of operation (the gestalt 1 of operation)), although the position in the reflected type liquid crystal display element of a light-scattering layer was made into the position shown in drawing 1 or drawing 3 , wherever the effect made into the aim of this invention may not necessarily be acquired only within this position and may be in [between a reflecting plate and an observer], the same effect is acquired -- there is no change in things

[0048] In addition, although the example which used the electric-field control birefringence effect as a liquid crystal mode of operation explained in explanation with the gestalt of the above operation, it can carry out similarly using a reflector which was mentioned above about the mode of operation which the use number of sheets of a polarizing plate can display by one or less sheet.

[0049] Furthermore, the content of this invention applicable also to any of the drive by switching elements, such as a simple matrix drive and TFT, is clear.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The cross section showing the basic composition of the reflected type liquid crystal display element of the (gestalt 1 of operation) of this invention
[Drawing 2] The conceptual diagram which defines the angle of the incident light to a light-scattering layer
[Drawing 3] The cross section showing the basic composition of the reflected type liquid crystal display element of the (gestalt 2 of operation) of this invention
[Drawing 4] The simplified diagram showing the dispersion property of the incident light within drawing showing the field where the degree field of diffusion angle of a light-scattering layer is included, and a reflected type liquid crystal display element
[Drawing 5] The cross section showing the basic composition of the reflected type liquid crystal display element by the conventional example
[Drawing 6] The cross section showing the basic composition of the reflected type liquid crystal display element by other conventional examples
[Description of Notations]
10a, 30a, 30b The angular dependence of light scattering is related in the direction of a layer normal, and it is an unsymmetrical light-scattering layer.
10b, 30c The angular dependence of light scattering is related in the direction of a layer normal, and it is a symmetrical light-scattering layer.
11 31 Polarizing plate
12 32 Birefringence film
13 33 Liquid crystal cell
14 34 Bottom transparent substrate
15 35 Light filter
16 36 Transparent substrate
17 37 Liquid crystal layer
18 38 Reflector
19 39 Bottom substrate
20 42 Light-scattering layer
43 Specular Reflection Board

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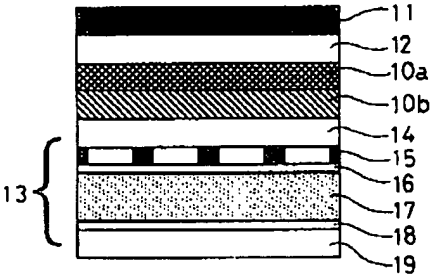
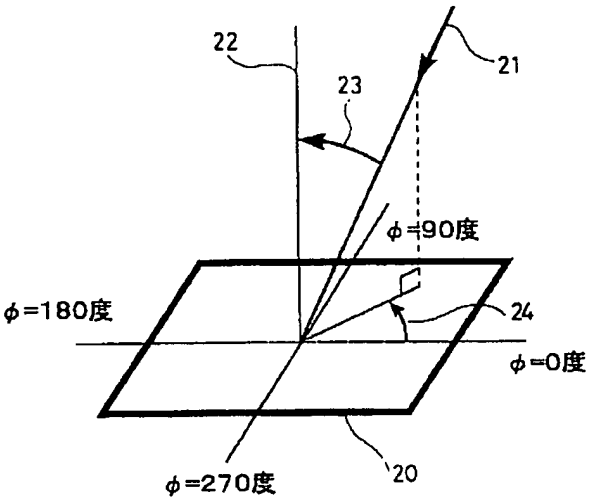
DRAWINGS

[Drawing 1]

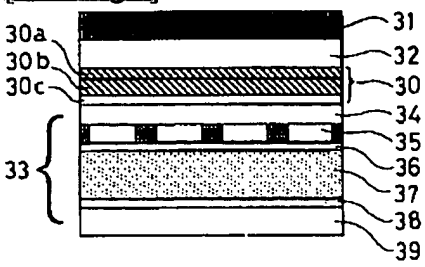


１０ａ…光散乱の角度依存性が層法線方向に関して非対称である光散乱層
１０ｂ…光散乱の角度依存性が層法線方向に関して対称である光散乱層
１１…偏光板
１２…複屈折フィルム
１３…液晶セル
１４…上側透明基板
１５…カラーフィルタ
１６…透明基板
１７…液晶層
１８…反射電極
１９…下側基板

[Drawing 2]

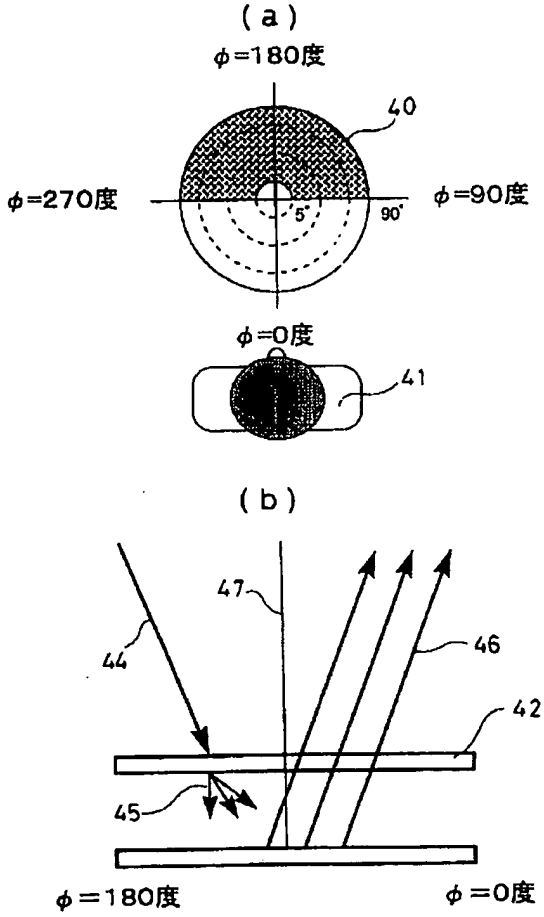


[Drawing 3]

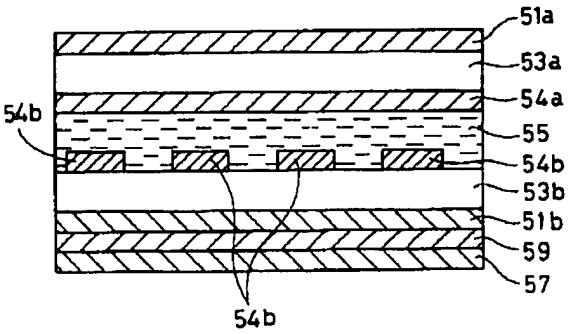


３０ａ，３０ｂ…光散乱の角度依存性が層法線方向に関して非対称である光散乱層
３０ｃ…光散乱の角度依存性が層法線方向に関して対称である光散乱層

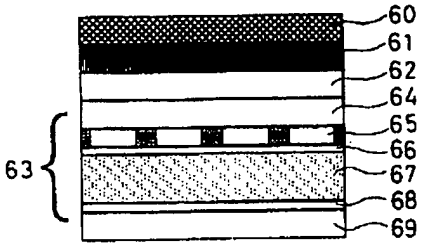
[Drawing 4]



[Drawing 5]



[Drawing 6]



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